Abdullah Alajmi

CHE-493

Assessment Report

Objective:

Matlab is a powerful tool to perform demonstrate and simulate different mathematical equations in the form of arrays. In this assignment we perform different inbuilt functions to obtained require results and also understand different present demo project to perfect our learning about matlab and its working.

First two tasks are performing different process on the function while the later two are for understanding the process i.e. feedbacks and controllers.

Question 1:

Part 1) Inverse laplace of the function using matlab.

MATLAB CODE

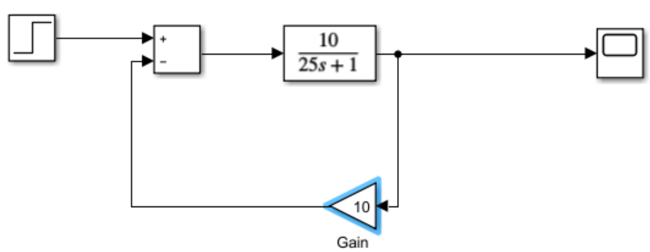
has.m

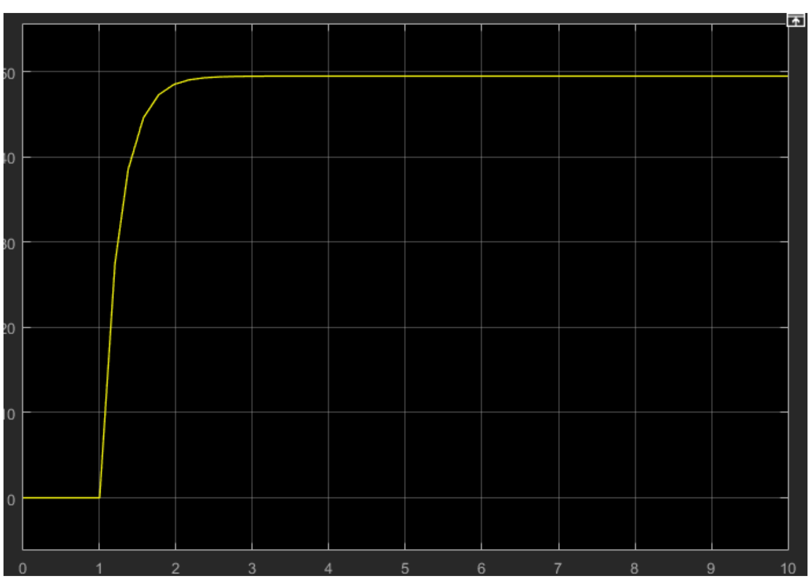
```
clear all
clc
syms s
fun=10/(25*s+1)
fun2=ilaplace(fun)
```

OUTPUT:

```
fun =

10/(25*s + 1)


fun2 =

(2*exp(-t/25))/5

fx >>
```

Part 2) This is a critically damped function.

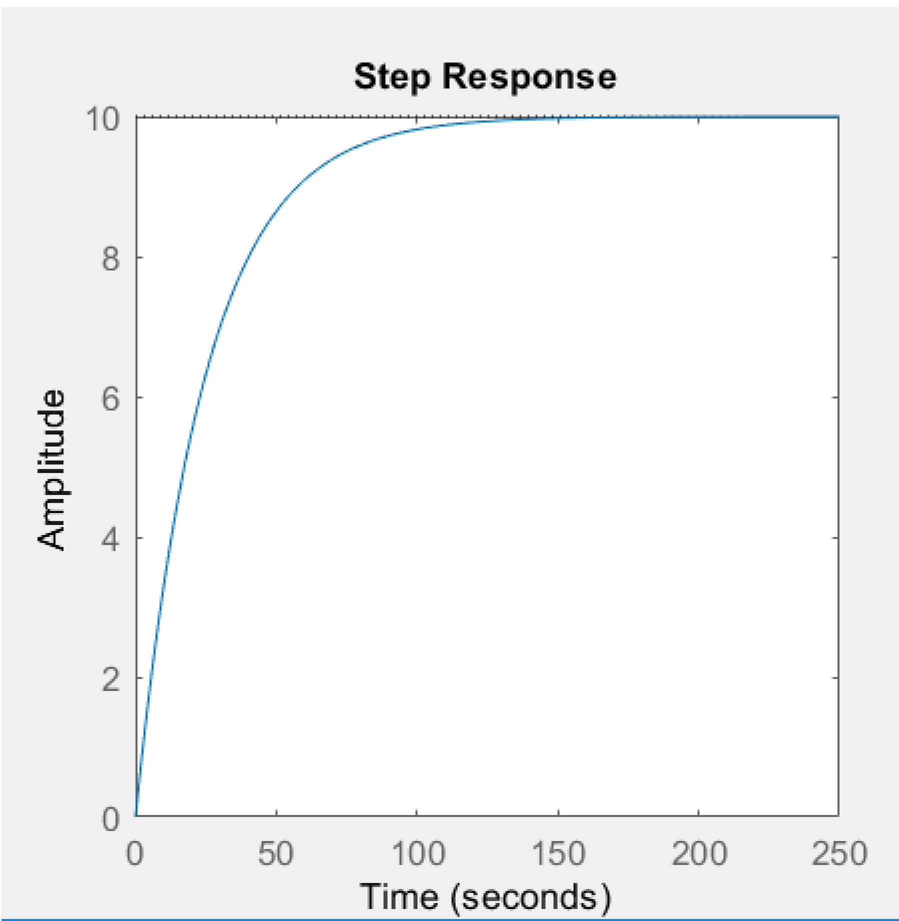




Matlab Code:

```
clc
clear all
num=[10];
den=[25 1];
tf1=tf(num,den)
step(tf1)
```

Output:

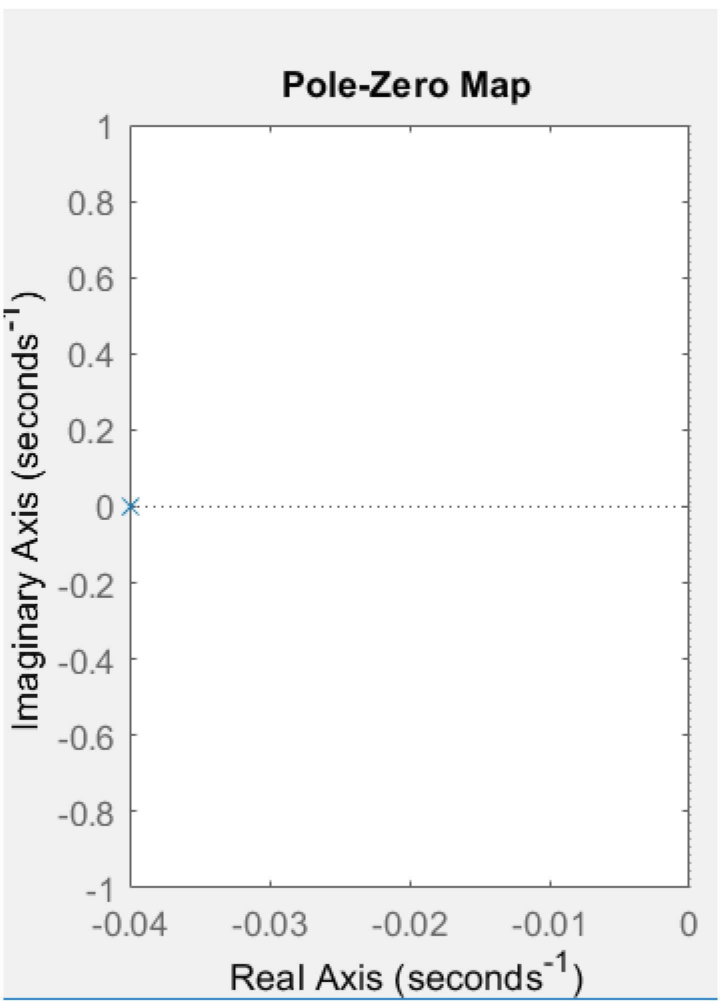


Part c) Following is the pole zero map of the function , the location of pole clearly indicate that the system is stable.

Matlab Code:

```
clc
clear all
num=[10];
den=[25 1];
tf1=tf(num,den)
pzmap(tf1)
```

Output:

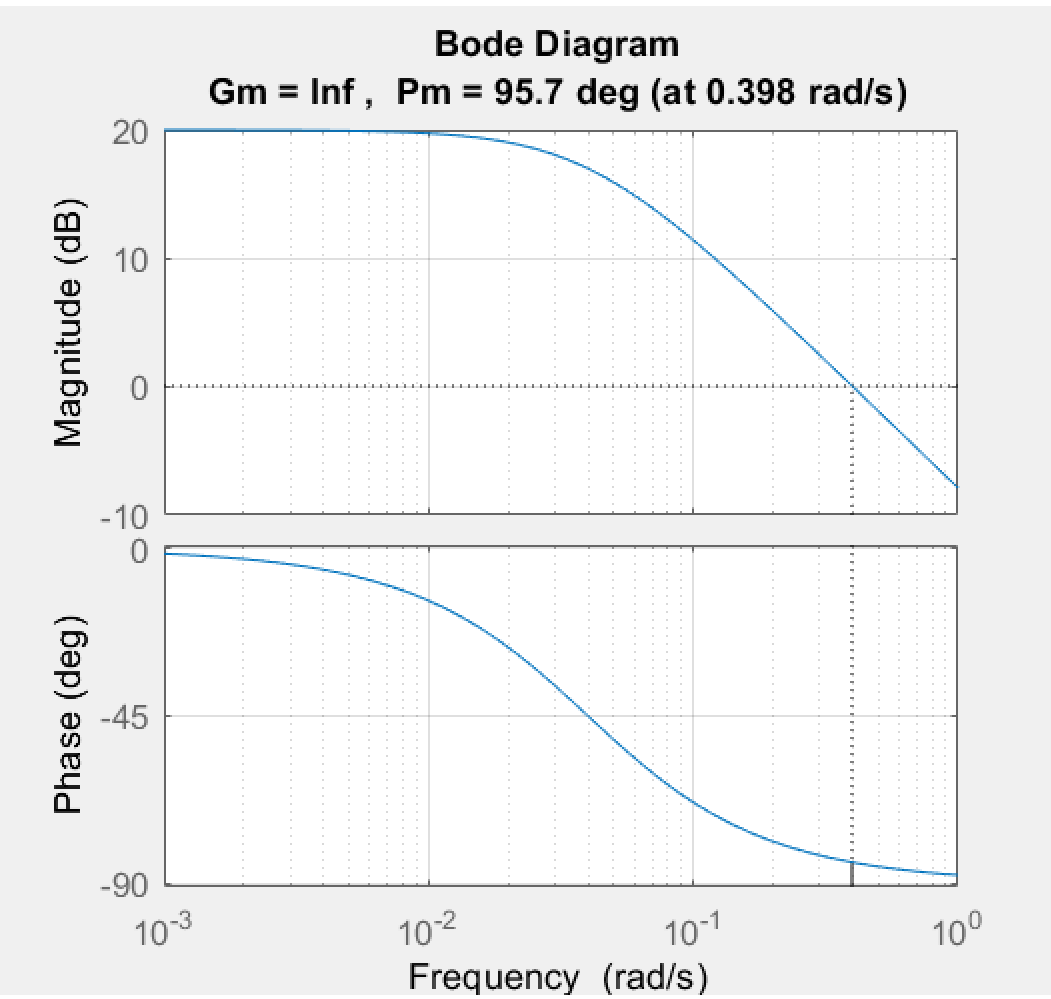


Part d) Following is the bode plot of the system, the graph of the bode plot also shows the gain margin and phase margin of the system.

Matlab Code:

```
clc
clear all
num=[10];
den=[25 1];
tf1=tf(num,den)
margin(tf1)
```

Output



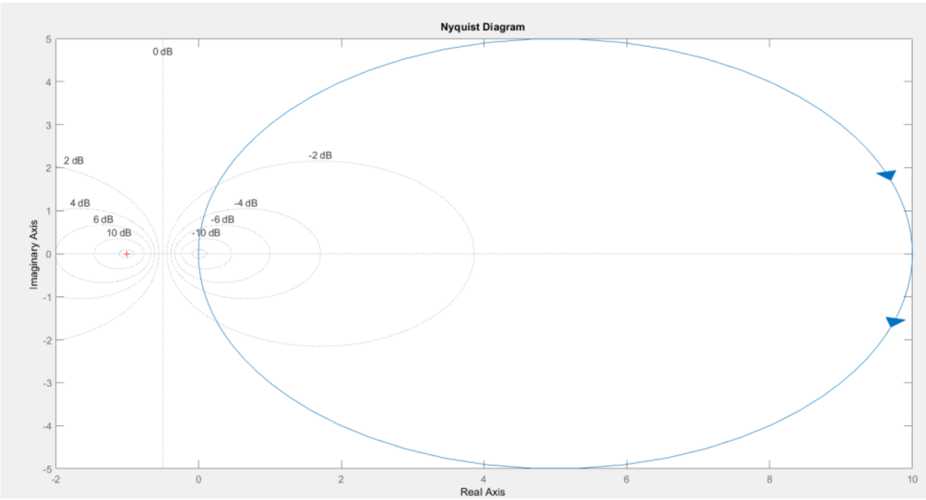
Part d) In this task, parameters are checked by nyquist plot and function is plotted in Matlab,

Following is the results of the plot which show that the system is stable because nither the gain margin point or phase margin point is encircled by the plot therefore system is stable.

Matlab Code:

```
clc
clear all
num=[10];
den=[25 1];
tf1=tf(num,den)
nyquistplot(tf1)
```

Output:



Question 2:

Part a): Inverse laplace of the given function is given below with is calculated using matlab tool.

Matlab Code:

```
has.m
clc
clear all
syms s
fun=(7*exp(-s*4))/(9*s+5)
func2=ilaplace(fun)
```

Output:

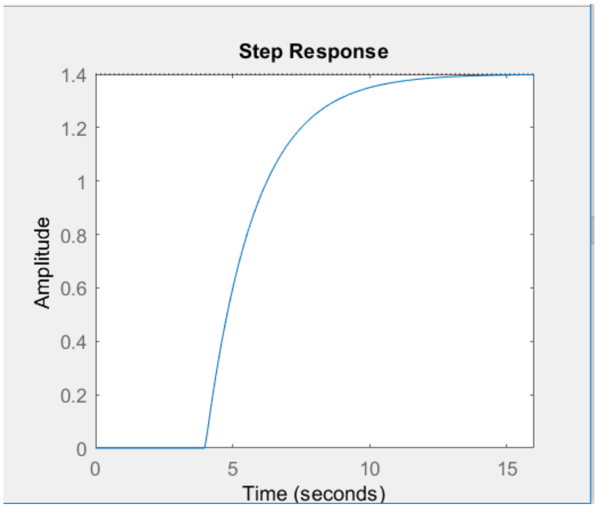
```
fun =

(7*exp(-4*s))/(9*s + 5)


func2 =

(7*heaviside(t - 4)*exp(20/9 - (5*t)/9))/9
```

Part b): The following function is critically damped to the unit step response.

Matlab Code:

```
clc
clear all
num=[7];
den=[9 5];
tf1=tf(num,den,'InputDelay',4)
step(tf1)
```

Output:

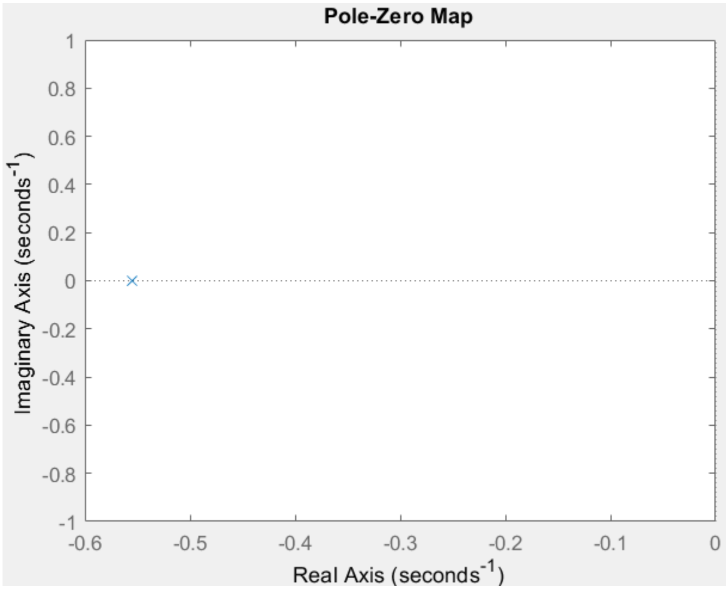


Part c): Such system are stable because they reach a finite value and remains on it as time pass.

Matlab Code:

```
Clc
clear all
num=[7];
den=[9 5];
tf1=tf(num,den,'InputDelay',4)
pzmap(tf1)
```

Output:

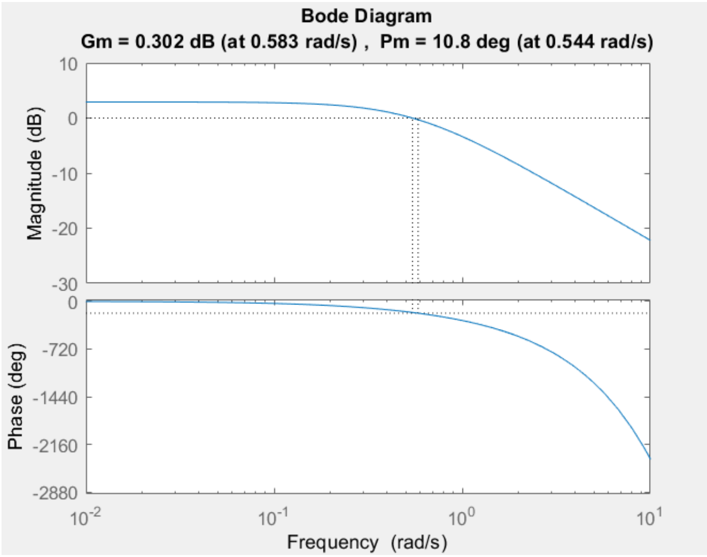


Part d): Bode plot of the given function is given below and the phase margins and gain margins are also calculated using matlab tool.

Matlab Code:

```
clc
clear all
num=[7];
den=[9 5];
tf1=tf(num,den,'InputDelay',4)
margin(tf1)
```

Output:

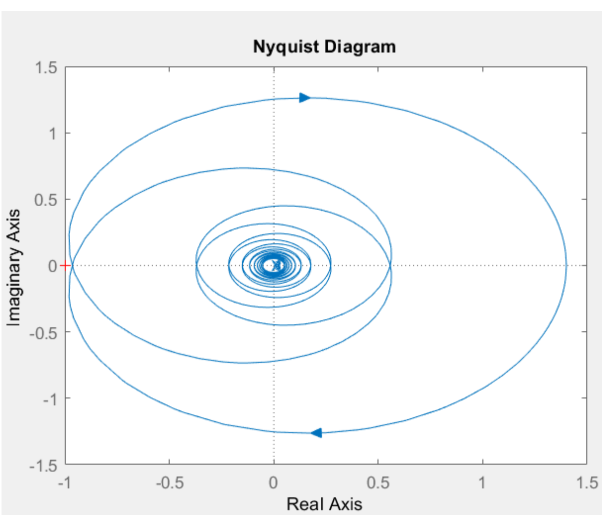


Part d): Following show the nyquist plot the given function and it shows that the plot encircles the pole of the function.

Matlab Code:

```
clc
clear all
num=[7];
den=[9 5];
tf1=tf(num,den,'InputDelay',4)
nyquistplot(tf1)
```

Output:



Question 3:

Process Model:

Process model means a mathematical model which represents a system behavior and the process in the mathematical terms i.e. controllers, feedback systems etc.

This is the model of a heat exchanger temperature control system. This model is simulated using Simulink and the purpose of this model is to reject temperature disturbances which is performed by using feedforward and feedback control networks.

Process Gain:

Process gains are the controlling parameters of the whole control system. In this system ‘Heat exchanger temperature control’ there are basically three process gains which are feedforward gain (Kf), proportional gain (Kp) and integral gain (Ki). Feedforward delay (Tau) is also a controlling parameter of the system.

Process Time Constant:

The process time constant is an important factor of process modelling as it indicates the response time of the process variable to the changes in the controller output.

In this control system the disturbance affect the temperature with a lag of 30-40 min (uncertainty).

Disturbance Model:

Disturbance model is the generic implementation of the real time disturbances or obstacles faces by the system when it actually run in real time environment.

In order to test any system’s reliability, system has to undergo some condition which describes its performance.

In this control system, temperature is effected by external disturbance signal to check how well the system perform in the real time environment. In this system a step input is forward to temperature disturbance model which implement it with some delay.

Disturbance Gain:

In this system the gain is implemented and controlled by feedforward control which has some gain Kf and system delay. So the disturbance gain is Kf.

Disturbance Time Constant:

It is the time taken by the disturbance to affect the control system. As the disturbance perimeters shown in the model it shows that the disturbance affects the temperature in 0-40 min approx.

Types of Controller Modes used:

Following types of controller modes are used in this control system:

- PI Controller for set points
- Feedforward controller for disturbance input

On the other hand if we talk about modes than both feedback and feedforward control is used.

Types of Control loops in the control block diagram:

There are two types of control used in this control system i.e. feedforward and feedback .Feedforward control loop is used for the input disturbance signal and feedback loop is used to manipulate the set points provided to the system.

Question 4:

Process Model:

This system shows the multi loop controller parameters of a distillation column. The Distillation column produces methanol and is represented as a linear model with delays. The digital multi-loop controller consists a decoupling matrix and two single-loop PI controllers. The parameters of both the single-loop controllers are tuned simultaneously to satisfy a 14 percent overshoot and 13 minute rise-time step response characteristics.

The controller consists of a static decoupling matrix and two single-loop PI controllers. The PI gains are initialized to K1=K2=1 and tau1=tau2=50 based on open-loop, feedforward settings.

Process Gain:

Process gain represent the controlling gain parameters of the control system. The controller consists of a static decoupling matrix and two single-loop PI controllers. The PI gains are initialized to K1=K2=1 and tau1=tau2=50 based on open-loop, feedforward settings.

Process Time Constant:

Process time constant is time taken by the controller to the process variable. Step change is input to the digital controller feedback system whose sampling interval is one minute. So each sample is processed after one minute.

Types of Controller Modes Used:

There are two types of controller modes used in the feedback system i.e. feedback control and feedforward control. In this control system two feedback PI controllers are used.

Types of control loops in the control block diagram:

In this control system, two single loop PI controllers are used which are single loop. Step change is input to these controller and they process the step change with one minute sampling time and steady state decoupling Matrix.